

A Review of the Distribution of Diploid, Triploid and Tetraploid Green Toads (*Bufo viridis* Complex) in Asia Including New Data from Iran and Pakistan¹

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Abstract.- A summary of the distribution of green toads containing most of the data published after the discovery of polyploid forms (1976) including a map, an index and a bibliography are presented and discussed. 21 Asian type localities of hitherto described nominal green toad taxa are shown. The tetraploids are distributed in high mountains and extremely continental regions with strong climatic shifts. Records of triploid specimens are situated in supposed contact zones between the parapatric diploid and tetraploid toads at foothills of Middle Asian high mountains, and triploid bisexual populations occur in the Karakoram and West-Himalayas. Habitats of diploids appear to be restricted to lowlands and valley grounds. Polyploids seem to be more resistant. The methods hitherto used for the determination of the ploidy level and their applicability are evaluated. We show new data on this species complex from Iran including cytometric, karyological, bioacoustic and morphological data and we draw taxonomic conclusions for tetraploid *Bufo oblongus*, diploid *Bufo viridis kermanensis*, and probably diploid *Bufo kavirensis*. New information on the distribution of triploids in northwestern Pakistan based on flow cytometric measurements is presented. The ploidy level of *Bufo latastii* is revealed to be diploid.

Key words.- Amphibia, Bufonidae, *Bufo viridis* complex, *Bufo oblongus* lectotype, *Bufo viridis kermanensis*, *Bufo kavirensis*, *Bufo latastii*, *Bufo pseudoraddei pseudoraddei*, *Bufo pseudoraddei baturae*, distribution, type localities, Asia, Iran, Pakistan, chromosomes, ploidy determination, calls, systematics

¹This paper is a chapter of the doctoral dissertation of M. Stöck.

Introduction

Since the discovery of tetraploid forms of the *Bufo viridis* complex in the northern Tien Shan (Bachmann et al., 1978; Mazik et al., 1976) many records of diploid, triploid and tetraploid green toads have been made, especially on the territory of the former Soviet Union and some few in other countries. New findings as the detection of possibly all-triploid, gonochoristic populations of this complex in the Karakoram range of Pakistan (Stöck et al., 1998, 1999) provide arguments that the number of investigations in this species complex will increase during the next years because not only zoogeographic and phylogenetic but also cytogenetic, bioacoustic and biochemical questions will be studied. Since a fundamental summary of the data on the territory of the former Soviet Union was done by Borkin et al. (1986a), the development of knowledge in this species complex has been dramatically increased.

Hence, the present paper was aimed to summarize the recent information about the distribution which is one of the preconditions for the understanding of the natural history of these toads. The data on chorology will also be an important prerequisite for a revision of systematics and nomenclature in this species complex.

We discuss the hitherto applied techniques of ploidy determination, the size of the (known) range of polyploid green toads, any detectable correlation of their occurrence with climatic/ecological factors, and we try to enlarge the knowledge about the ploidy level of taxa hitherto described from various type localities.

Because the knowledge on the ploidy of green toads from the territory of Iran and Pakistan is very scarce, we also present and discuss some new, sporadically collected data from different sources, and first results of a field excursion to Pakistan.

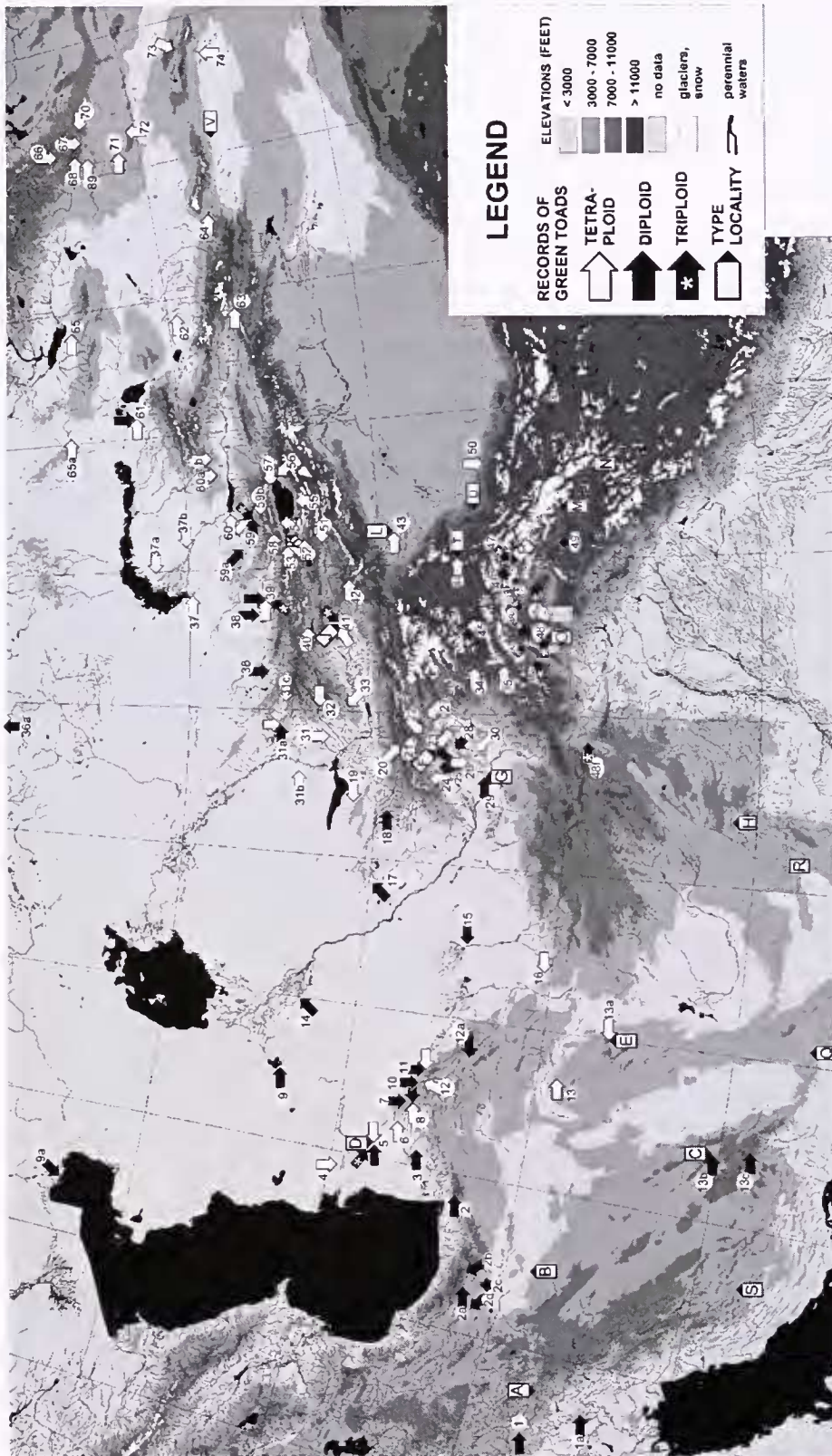


Figure 1. Map of Middle and Central Asia and parts of the Middle East with records of diploid, triploid and tetraploid green toads after 1976. For code numbers see appendix.

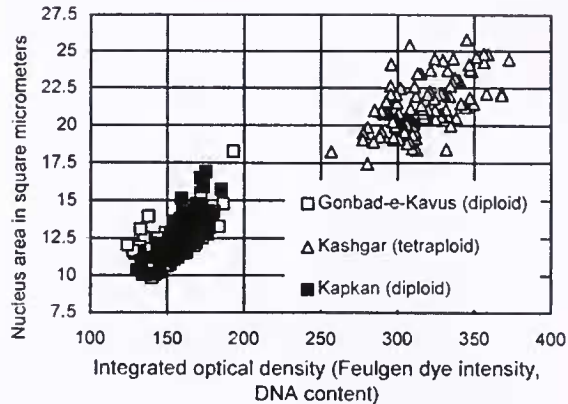


Figure 2. Diagram showing the nucleus projection area in relationship to the integrated optical density (the DNA content, respectively) of 100 Feulgen stained erythrocyte nuclei of a diploid standard specimen from 50 km E Gonbad-e-Kavus (3 in Fig. 1), a tetraploid standard specimen from Kashgar (43) and the diploid specimen from Kapkan (12a).

Material and Methods

New data from Iran

We used three sources: Martens (unpubl.) recorded mating calls of green toads from Fasham (4 July 1978, 23.00) and Polur (30 June 1978, 22.30) which were analyzed according to Stöck (1998a). Frynta collected in 1997 and 1998 (comp. Frynta et al., 1997) green toads, among them five living specimens from Gholaman (MTKD D 41350), Kapkan (MTKD D 41351), Baghestan (CUP AMPH/IRA/130) and Choqua Zambil (MTKD D 41352, 41353) whose ploidy levels were analyzed with erythrocyte measurements, microdensitometrical DNA-measurements and/or karyological techniques (Schmid, 1978; Stöck and Grosse, 1997a). Stöck visited in June 1998 Kerman, the type locality of *Bufo viridis kermanensis* Eiselt & Schmidler, 1971, and Birjand, the type locality of *Bufo oblongus* Nikolsky, 1896. A mating call of a single male from Birjand recorded by Stöck in the late phase of the breeding period (8 June 1998, 21.30) was analyzed as described by Stöck (1998a). Seven specimens from Kerman (among them ZFMK 69909 to 69911, MTKD D 40730, 40731, 41348, 41349) and five adult and six juvenile specimens from Birjand (among them ZFMK 69901 to 69908, MTKD D 40729, 41346, 41347) were examined either by flow cytometry as described by Stöck et al. (1999) or karyologically according to Schmid (1978). For morphological comparisons we included type material - *Bufo kavirensis*: GNM Ba. ex. 1278 (holotype), GNM Ba.

ex. 1280 (paratype); *B. luristanicus*: ZMUC R 13221 (holotype); *B. oblongus*: ZISP 1952.1 (now lectotype), ZISP 1952.2 (now paralectotype). Institutional abbreviations are as listed in Leviton et al. (1985); for localities see Fig. 1.

New data from Pakistan

In June and July 2000, Stöck and Dressel traveled in the Northern Areas and North West Frontier Province of Pakistan. In the Hunza valley of the Karakoram Range near Karimabad ($n = 8$), and Pasu ($n = 50$), at the tributaries of the Gilgit river near Gupis ($n = 2$), at the Shandur pass ($n = 8$), and in the Chitral valley, near Buni ($n = 2$) and in Chitral City ($n = 8$), blood samples for ploidy determination of anesthetized adult green toads were taken, stored in 70% ethanol and refrigerated until flow cytometry according to Stöck et al. (1999).

In Skardu, at the western margin of the type region ("Ladak") of *Bufo latastii* Boulenger, 1882, blood samples of 15 adult toads of this species were taken, among them ZMB 62721 to 62726. A mating call of a single male (24 June 2000, 21.30) was recorded and analysed as described (Stöck 1998a).

For morphological comparisons we examined the lectotype of *Bufo latastii* BMNH 1947.2.21.28 (formerly 72.4.17.223; Stöck et al., 1999; Fig. 1).

Map (Fig. 1), list of records with ploidy detection and type localities of nominal Asian green toad taxa (Appendix)

The map contains most of the localities or regions where diploid, tetraploid and/or triploid toads have been recorded in Middle and Central Asia and the eastern parts of the Middle East after 1976, the year of the first detection of polyploids. Our map covers all regions where polyploid green toads have been found. These records (numbers 1 to 74) from the literature have been made using various methods for identification or determination of the taxa and/or ploidy levels. Some methods are not unambiguous and might therefore cause errors. Consequently, it was necessary to evaluate the methods which were utilized for the determination of the ploidy level because not all data are indisputable. In the case of the numbers 1 to 74, the present article only includes papers if they either contain statements on the ploidy of the toads or data appearing suitable to draw a conclusion to the ploidy (e.g. call data, see below). However, even if authors distinguished between diploid and tetraploid toads, in rare cases, especially in abstracts, the localities of the records were not precisely published (e.g., Fikhtman, 1989) or it was impossible to deduce from the publi-

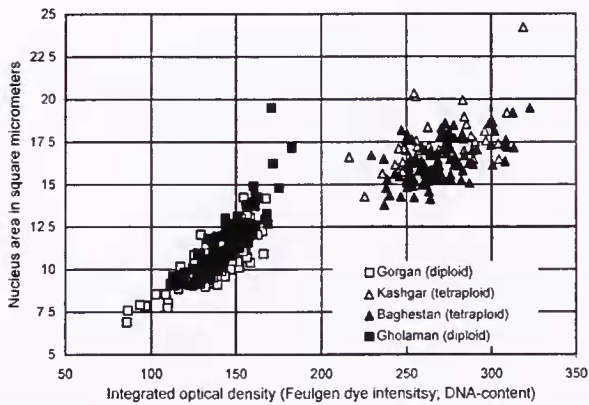


Figure 3. Diagram showing the nucleus projection area in relationship to the integrated optical density (the DNA content, respectively) of 100 Feulgen stained erythrocyte nuclei of a diploid standard specimen from S of Gorgan (2), 50 nuclei of a tetraploid standard specimen from Kashgar (43), 100 nuclei of the tetraploid specimen from Baghestan (13) and 100 nuclei of the diploid specimen from Gholaman (1).

cation to the exact ploidy of toads from a concrete locality (e.g., Castellano and Giacoma, 1998) and/or the method of ploidy determination was not mentioned (e.g., Pisanets & Vasilenko, 1995). Since no polyploid green toads have been found in the Caucasus (e.g., Kuzmin 1995: 187), we disregarded this area. If the information about a region but not a special position was available, the record is not shown in the map but listed in the appendix, and marked with a "?" (instead a number) in the line next to the nearest concrete record. Furthermore, we present some hitherto unpublished single records ("Stöck, unpubl.") from Kazakhstan and Kyrgyzstan.

We used different maps (Anonymous, 1993; DMAAC) and/or the descriptions and sketch maps in the literature (e.g., Borkin et al., 1986a) for the localization of the records. If they were available, the appendix contains the condensed descriptions of the localities, the geographic position and the method of ploidy determination.

The second part of the appendix (letters A to V) contains the 21 Asian type localities shown in Fig. 1 and represents a preliminary precondition for a systematic discussion. The bibliography in that part only comprises a choice of the literature which either discussed the systematic rank of a taxon or shows details suitable to draw a conclusion to the ploidy. Some descriptions of taxa either mentioned regions only but no special type locality (e.g., Boulenger, 1882: "Ladak" for *B. latastii*), but were drawn in the map; others presented a confusing diversity of type locali-

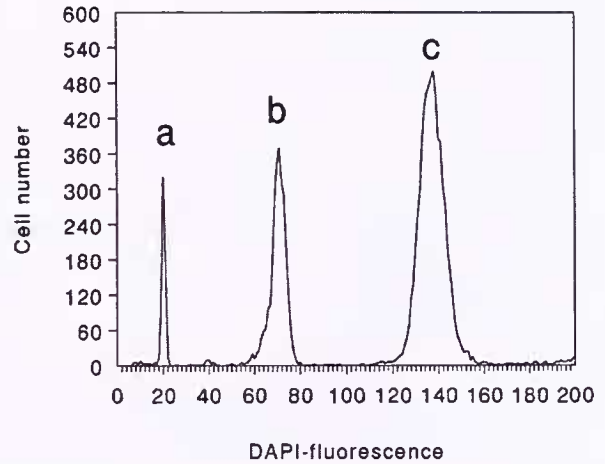


Figure 4. Histogram obtained by DNA flow cytometry from a mixture of DAPI stained blood samples with chicken as the standard (a), CV = 2.63%, a diploid green toad from Kerman, type locality of *Bufo viridis kermanensis*, (b), CV = 3.62%, and a tetraploid green toad from Birjand, type locality of *Bufo oblongus*, (c), CV = 3.31%. Total cell number 10 327.

ties covering large parts of Central Asia (e.g., Bedriaga, 1898: *B. viridis* var. *pezowii* and var. *strauchi* with a type series from 4 or 14 localities, respectively, distributed from Mongolia to the Pamirs). In the latter cases, only some localities are shown, and this is mentioned in the appendix. In future, such taxonomic problems should be resolved by careful lectotype designations leading to type locality restrictions as a basis of a revision. Finally, the status of some old names, at least for diploid green toads, still remains unclear (see ref. in Kuzmin, 1999: 251, 264). They were not shown in the map or originated from regions outside of it.

Results and Discussion

New data from Iran

Cytometric and karyological data. A large male from Kapkan (Fig. 1: 12a) in the East-Iranian part of the Kopet Dagh which we considered to represent *Bufo viridis turanensis* was identified to be diploid (Fig. 2). A male *Bufo viridis* ssp. from Gholaman (Fig. 1: 1; Fig. 8C) in the Zagros mountains, was diploid (Fig. 3); two additional males from Choqa Zanbil (Fig. 1: 1a) below the south-western foot of the Zagros mountains were also diploid.

All toads examined from Kerman, the type locality of *Bufo viridis kermanensis*, were found to be diploid as well (Fig. 4). This agrees with the contemporaneously published results of Borkin et al. (2000). We detected (Fig. 3) the first tetraploid toad in

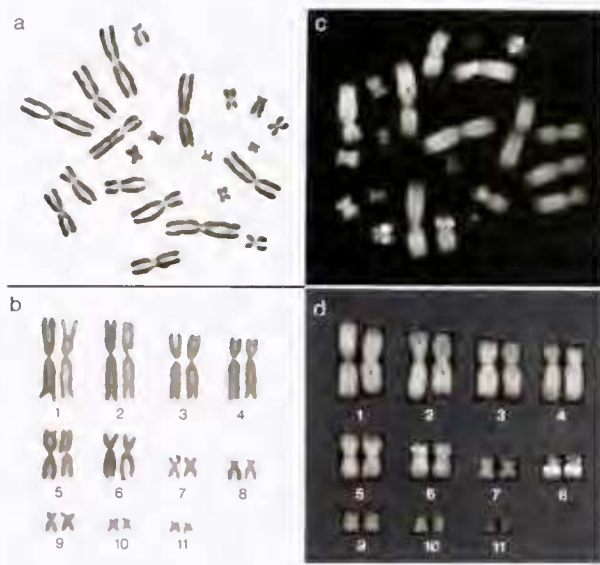


Figure 5. Chromosomes of diploid male *Bufo viridis kermanensis* from Kerman: a - Giemsa-stained metaphase, b - Giemsa-stained karyotype, c - Q-banded metaphase, d - Q-banded karyotype.

Iran near Baghestan (Fig. 1: 13; Fig. 8F) in the mountainous region north-eastern of the Central Iranian Plateau (abstract by Stöck et al., 1998). A sample of five toads from Birjand (Fig. 1: 13a), the type locality (Fig. 1: E) of *Bufo oblongus*, was found to be tetraploid (Fig. 4). Table 1 outlines the results of the flow cytometric measurements in specimens from Kerman and Birjand. Table 2 summarizes the results of erythrocyte size measurements. The erythrocyte sizes were typical of diploid and tetraploid green toads, respectively, according to Stöck and Grosse (1997a). The mean DNA content of *B. oblongus* (17.02 pg) rather corresponds to that of tetraploids from Kashgar (17.5 pg; Stöck, 1998b) measured with the same technique, but during another session.

The Giemsa-staining (Fig. 5a, b) revealed a diploid karyotype of *B. viridis kermanensis*. These conventionally stained chromosomes possess the characters of those from some other Eurasian diploid *Bufo viridis* which have been examined until now (Birstein, 1981; Bogart, 1972; Roth and Ráb, 1987; Schmid, 1978; Ullerich, 1966). The pair 6 terminally exhibits in its long arms a secondary constriction which is caused by the telomeric position of the nucleolus organizer regions (NORs) in *B. viridis* (see also Roth and Ráb, 1987; Schmid 1978). The Quinacrine-banding in chromosomes of *B. viridis kermanensis* (Fig. 5c, d) shows differently intensive fluorescing chromosomal regions in pairs 6 to 11, but distinct bright fluorescence



Figure 6. Chromosomes of a tetraploid female *Bufo oblongus* from Birjand. a - Giemsa-stained metaphase, b - Giemsa-stained karyotype, c - Q-banded metaphase, d - Q-banded karyotype.

was only found in short and long arms of pairs 6 and 8. Birstein (1981) detected Q-bands in a *B. viridis* from the Crimea in pairs 6 to 11 (the most distinct ones in both arms of pairs 7, 10, and 11). In a triploid taxon (*Bufo pseudoraddei baturae*) of the *B. viridis* complex from the Karakoram, we found Q-bands in the long arms close to the centromere of triplet 1, in the short arms of triplets 6 and 7 and in both arms of triplets 8 to 11 (Stöck et al., 1999).

Similarly, the karyotype of the tetraploid *Bufo oblongus* exhibits Q-bands in chromosomes of the quartets 1, 6 to 11 (Fig. 6c, d). The most interesting finding is the occurrence of Q-bands in the short arms of only two out of the chromosomes of quartet 6. These two chromosomes have also larger long arms than the two remaining Q-negative chromosomes, and therefore, we conclude that the Q-positive pair also represents the only one which carries the telomeric NORs as Roth and Ráb (1987) found in tetraploid toads from Kyrgyzstan. We are preparing a detailed cytogenetic study. Like in the triplet 1 of triploids from Karakoram, one or two chromosomes of quartet 1 in *B. oblongus* possess Q-bands in their long arms. Furthermore, additional differences are visible in the occurrence and position of Q-bands among the chromosomes in each of the quartets 7, 8 and 10 (Fig. 6c, d). These observations in *B. oblongus* provide arguments for considering this tetraploid form allopolyploid. The question of autopolyploidy or allopolyploidy of polyploids from various

Table 1. DNA content in diploid toads from Kerman (*Bufo viridis kermanensis*), diploid toads from Choqua Zanbil (*B. viridis* ssp.), tetraploid toads from Birjand (*Bufo oblongus*), and diploid *B. latastii* from Skardu measured by flow cytometry of DAPI stained erythrocytes with chicken nuclei (= 2.34 pg DNA/nucleus) as a standard. SD = standard deviation.

	Kerman, diploid (N = 7)			C. Zanbil, diploid (N = 2)			Birjand, tetraploid (N = 5)			Skardu, diploid (N = 15)		
	Ratio to chicken standard (= 1)	Ratio to Mean (%)	Absolute DNA content (pg)	Ratio to chicken standard (= 1)	Ratio to Mean (%)	Absolute DNA content (pg)	Ratio to chicken standard (= 1)	Ratio to Mean (%)	Absolute DNA content (pg)	Ratio to chicken standard (= 1)	Ratio to Mean (%)	Absolute DNA content (pg)
Mean	3.43	100	8.02	3.59	100	8.42	7.27	100	17.02	4.13	100	9.68
Min	3.25	94.75	7.61	3.56	99.04	8.34	7.04	96.83	16.47	3.77	91.21	8.83
Max	3.69	107.58	8.63	3.63	100.95	8.50	7.57	104.13	17.71	4.59	110.95	10.74
SD	0.17	-	0.40	0.05	-	0.11	0.19	-	0.45	0.25	-	0.27

Table 2. Erythrocyte size (projection areas of 30 red blood cells per toad were measured) in five tetraploid specimens from Birjand (*B. oblongus*), a tetraploid specimen from Baghestan, six diploid specimens from Kerman (*B. viridis kermanensis*), a diploid specimen from Kapkan, a diploid specimen from Gholaman, and two diploid specimens from Choqua Zanbil.

Parameter (μm^2)	Locality (ploidy)	Birjand (4n = 44) N = 5	Baghestan (4n = 44) N = 1	Kerman (2n = 22) N = 6	Kapkan (2n = 22) N = 1	Gholaman (2n = 22) N = 1	C. Zanbil (2n = 22) N = 2
Mean of means in the population		353.87	335.98	256.38	272.24	248.39	236.26
Maximal mean in the population		374.30	335.98	274.93	272.24	248.39	181.47
Minimal mean in the population		333.03	335.98	224.40	272.24	248.39	286.32
Largest cell measured		463.29	413.50	358.91	318.11	322.77	181.47
Smallest cell measured		274.07	280.11	183.95	216.37	216.21	286.32
Mean standard deviation in the pop.		33.62	30.80	23.22	21.99	22.17	22.94

localities has been controversially discussed (for overview see Balleto et al., 1999; Stöck et al., 1999). As compared with conventionally stained tetraploid karyotypes (e.g., Borkin et al., 1986b, c; Borkin and Kuzmin, 1988; Orlova & Uteshev, 1986; Pisanets, 1978; Roth & Ráb, 1986, 1987; Stöck, 1998b; Toktosunov, 1984; Whu & Zhao, 1987), that of *B. oblongus* (Fig. 6a, b) does not exhibit visible differences.

Mating calls (Fig. 7, Table 3). The mating call data from Lar valley (Andrén and Nilson, 1979), Fasham and Polur suggest that these toads are probably diploid (see below for methodical questions). The same prediction (Stöck, 1998a) is possible for the toads from Cheshmeh-ye-Sefid-Ab, the type locality of *Bufo kavi-rensensis*. The mating call data from Polur (2a) and Fasham (2b) and the data from Lar valley (2b) and Gorgan (2) refer to the occurrence of (only) diploid

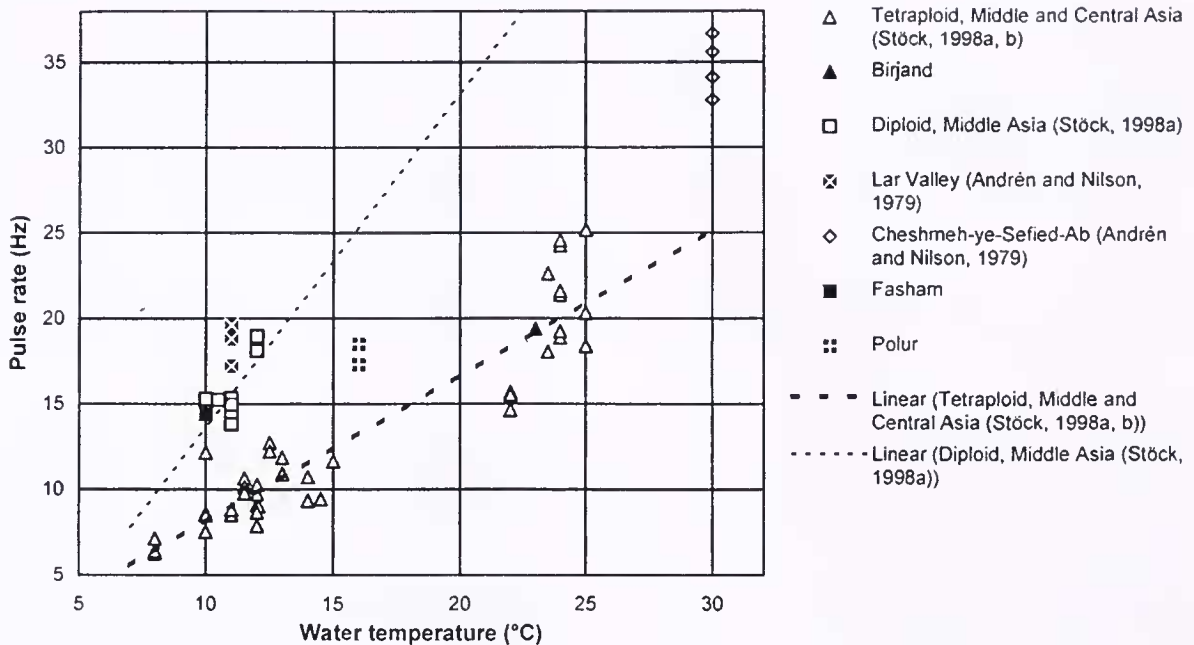


Figure 7. Pulse rate of mating calls of green toads from Iran in comparison with pulse rate of diploid and tetraploid toads from Middle and Central Asia. Birjand: type locality of *Bufo oblongus* Nikolsky, 1896. Toads from Birjand were found to be tetraploid (Fig. 4). Cheshmeh-ye-Sefid-Ab: type locality of *Bufo kavirensis*, Andrén and Nilson, 1979: the call data appear to elucidate that the taxon is diploid. Call data from Lar valley (Andrén and Nilson, 1979), Fasham and Polur (present study) provide arguments that these toads are diploid.

green toads in the Elburz mountains and confirm the evolutionary conservatism of the mating calls (disc. in Stöck, 1998b; Stöck et al., 1999). The single mating call of a tetraploid male (13a) from the type locality, Birjand (E), of *Bufo oblongus* confirmed previous data on tetraploids from various regions of Middle and Central Asia (Castellano et al., 1998; Stöck, 1998a, b).

Morphology and Taxonomy (Fig. 8). Although the locality (1) is relatively close to the type locality (A) of *Bufo luristanicus* (Schmidt, 1952), the morphology of the toads from Gholaman (Fig. 8C) and Choqa Zanbil differs completely from that of the *B. luristanicus* holotype (Fig. 8H). This confirmed once more the occurrence of at least two different green toad taxa in the north-western Zagros mountains of Iran as already Schmidtler and Schmidtler (1969) as well as Eiselt and Schmidtler (1973) stated. First, the form which was previously (Schmidtler and Schmidtler, 1969; Mertens, 1971b; Eiselt and Schmidtler, 1973) called *B. viridis arabicus* and to which the diploid toads from Gholaman and Choqa Zanbil belong to. Now, the name "arabicus" is no longer applicable since Balletto et al. (1985) restricted it to *B. arabicus* Heyden, 1827 from the Arabian Peninsula. Therefore, we preliminarily use the term *Bufo viridis* ssp. for them. The second taxon occurring in the north-western Zagros

mountains until eastern Iraq (Afrasiab and Ali, 1988) is *B. (surdus) luristanicus*. As to be seen in the appendix, the ploidy level of all three subspecies of *B. surdus* distinguished by Schmidtler and Schmidtler (1969) and Eiselt and Schmidtler (1973) is still unknown (cp. Balouch and Kami, 1995).

The seven topotypic specimens of *Bufo viridis kermanensis* from Kerman (13b) are very similar to the holotype (NMW 19647) shown and described by Eiselt & Schmidtler (1971, 1973). This diploid form is different from the large sized diploid *B. viridis turanensis* as already Hemmer et al. (1978) stated and which was confirmed by our data.

The diagnostic differences between *Bufo kavirensis* and *B. viridis kermanensis* consist according to Andrén and Nilson (1979) in only two morphometric traits (I: ratio "distance between posterior border of nostril and anterior corner of eye/internal nasal distance" 0.80 - 1.06 in *B. kavirensis* and 1.21 - 1.55 in *B. v. kermanensis*; II: ratio "width of upper eyelid / interorbital distance" 1.11 - 1.61 in *B. kavirensis* and 1.51 - 2.00 in *B. v. kermanensis*). Both ratios were not confirmed because the first ranged for our seven *B. viridis kermanensis* from 0.9 - 1.18 (and 0.93 - 1.05 in two specimens, Fig. 1: 13c, by Borkin et al., 2000); the second ratio varied also strongly from 0.8 - 2.92 (and 1.83 -

2.31, Borkin et al., 2000). Including the data shown above, we preliminarily consider (diploid) *B. kavirensis* to be a junior synonym of diploid *B. viridis kermanensis*. This also agrees with the range presumed by Eiselt and Schmidtler (1973) for their taxon. The relationships between diploid *B. viridis kermanensis* and diploid *B. viridis* ssp. (previously called *B. viridis arabicus*, see above) require additional investigations.

The morphological differences between *Bufo oblongus* (Fig. 8A, B, D) and *B. viridis kermanensis* (Fig. 8E) which were considered to be "very sharp

regarding neighboring races" (Eiselt and Schmidtler, 1973) were now explained by the different ploidy levels. The females of *B. oblongus* (e.g., Fig. 8B) examined from Birjand exhibited a coloration pattern which is very similar to that of the specimen ZISP 1952.1 from the type series (Fig. 8A). We therefore designate it here as the lectotype of *B. oblongus*, Nikolsky, 1896, and we consider this taxon according to the topotypes to be tetraploid. This demonstration of tetraploidy for *B. oblongus* is important for the taxonomy of green toads in Asia because the name is

Table 3. Mating call data of green toads from different regions of Iran. 50 km E Gonbad-e-Kavus, Lar valley, Polur, Fasham: *Bufo viridis* - probably diploid; Cheshmeh-ye-Sefid-Ab: *Bufo kavirensis* - probably diploid. Birjand: *Bufo oblongus* - tetraploid.

Locality (code in Fig. 1)	Male	AirT (°C)	WaterT (°C)	Interpulse interval (ms)	Pulse duration (ms)	Pulse rate (s ⁻¹)	Fundamental frequency (Hz)	Call duration (s) [N of calls measured]	Intercall interval (s) [N of intervals measured]	Source
50 km E Gonbad-e-	1	12.5	16.0	22.0	24.0	21.7	1349	-	-	Stöck (1998a)
Kavus	2	12.5	16.0	20.5	28.4	20.44	-	-	-	Stöck (1998a)
Lar valley	3	?	11	-	-	18.8	1200	4.16 [1]	-	Andrén and Nilson (1979)
(2b)	4	?	11	-	-	17.2	1400	4.43 [2]	-	Andrén and Nilson (1979)
	5	?	11	-	-	19.6	1325	4.8 - 5.4 [2]	-	Andrén and Nilson (1979)
Polur (2b)	6	16	14	26.5	27.4	18.5	1291	2.7 - 3.1 [3]	4.6 - 6.3 [2]	present paper
	6	16	14	30.7	27.1	17.3	1291	2.4 - 3.2 [5]	2.6 - 6.0 [4]	present paper
Fasham (2a)	7	14	10	34.5	34.9	14.4	1076	2.9 - 6.2 [4]	6.9 - 10.1 [3]	present paper
Cheshmeh-	8	-	30	-	-	36.7	1175	1.26 [2]	-	Andrén and Nilson (1979)
ye- Sefid	9	-	30	-	-	36.7	1275	1.32 [2]	-	Andrén and Nilson (1979)
-Ab (B)	10	-	30	-	-	32.8	1125	2.9 [2]	-	Andrén and Nilson (1979)
	11	-	30	-	-	34.1	1075	1.74 [2]	-	Andrén and Nilson (1979)
	12	-	30	-	-	35.6	1150	1.37 [2]	-	Andrén and Nilson (1979)
Birjand (13a)	13	23	23	23.8	27.8	19.4	1378	2.7 - 2.9 [2]	4.3 [1]	present paper

Table 4. Mating call data of triploid *Bufo pseudoraddei baturae* in comparison with *Bufo latastii* from India and Pakistan.

Taxon (ploidy)	Locality (code in Fig. 1)	WaterT (°C)	Interpulse interval (ms)	Pulse duration (ms)	Pulse rate (s ⁻¹)	Fundamental frequency (Hz)	Call duration (s) [N of calls measured]	Intercall interval (s) [N of intervals measured]	Source
<i>B. latastii</i>	Kargil and Tangmarg, Pahalgam	no data	no data	30-60	8-13	1200-1300	2.5-6.1 [data from spectrograms]	no data	Dubois and Martens (1977)
<i>B. latastii</i> (diploid)	Skardu (49)	13	54.3	39.8	10.62	1470	4.3-6.9 [3]	4.9-6.9 [3]	present paper
<i>B. pseudoraddei baturae</i> (triploid)	Gilgit (48a) and Pasu (47, P)	7-27	27.3-86.2	19-56.7	7.38-21.28	1378-1636	1.2-4.2 [25]	2.0-6.8 [25]	Stöck et al. (1999), unpubl.

(one of) the oldest available name(s) for tetraploids in Middle and Central Asia.

New data from Pakistan

Cytometric data. Among the triploid populations reported by Stöck et al. (1999), DNA-measurements in additional specimens confirmed bisexual triploidy in altogether 82 adult specimens of *Bufo pseudoraddei baturae* from Pasu (47). Exclusively triploids were also detected by our sample survey along the upper tributaries of the Hunza (47a) and Gilgit river systems (48b, c). The record of triploids at the Shandur pass (48c, 3720 m a.s.l.) and the occurrence of triploids in the Chitral valley (48d, e) demonstrated their continuous distribution, i.e. a more or less connected range. In Chitral, sympatric occurrence of triploids with *B. stomaticus* was observed.

The flow cytometric measurements (Tab. 1, Fig. 9E) revealed all 15 specimens of *Bufo latastii* from Skardu (49) to be diploid. Although the absolute values cover a relatively large range resulting from the fixation of samples in ethanol in the field, apparently the DNA content of *B. latastii* is about 15 to 20% higher than that of diploid *B. viridis* ssp. and *B. v. kermanensis* from Iran. The karyotype of toads from Skardu comprises $2n = 22$ chromosomes; a detailed cytogenetic study will be published elsewhere. It remains to be clarified if the karyological study on a "*Bufo* spec." from Kashmir (Duda & Opendar, 1971) really represented *B. latastii* as Dubois and Martens (1977) and Roth and Ráb (1986) presumed when they considered this species diploid. In any case, long lasting speculations (see appendix: M) on the ploidy of *B. latastii* which previously were connected with signifi-

cant uncertainties in the systematics of Central Asian green toads (Borkin et al. 2000; Stöck et al., 1999) have been finished now.

Mating calls (Table 4). Mating call parameters of a single diploid male *B. latastii* from Skardu were found in the range reported for this species by Dubois and Martens (1977) from Kashmir and Ladakh. As discussed by Stöck et al. (1999), the *B. latastii* calls are rather similar to those of triploid *B. pseudoraddei baturae* from Western Karakoram and *B. p. pseudoraddei* from Western Himalayas. This can be either interpreted as convergences in isolated species or may result from the participation of *B. latastii* genes in the probably allotriploid *B. p. baturae*, but up to now, exact explanations are not available.

Morphology and taxonomy. The morphology of triploids from Shandur Pass (48c) and Chitral (48d, e) was similar to that of *B. pseudoraddei baturae* from Gilgit (Stöck et al., 1999); therefore, we consider them to represent the same taxon.

The 15 toads examined from Skardu (49) were clearly identified as *Bufo latastii* Boulenger, 1882 (= *B. siachinensis* Khan, 1997). The external morphology and the coloration are very similar to the lectotype of *B. latastii* (Fig. 9A-D). Furthermore, the characteristic ventral dark pattern comprising blackish, up to eye-sized, sometimes connected spots and an abrupt darkening of the caudal third of the belly including the base of the hind legs was found to occur in the *B. latastii* lectotype, the *B. siachinensis* holotype, and always in the toads from Skardu also (Fig. 9C, D).

Table 5. Evaluation (overview) of methods previously used by different authors for the determination of diploid and polyploid green toads. For detailed information see text.

Method of determination	Unequivocalness	Applicability in the field	Abbr. in the appendix
Karyotype, karyogram, counting of chromosomes	yes	no	chrom. count.
Flow cytometry	yes, if applied professionally	no, but blood samples can shortly be stored in ethanol	flow cytom.
Microdensitometry (Feulgen staining), cytometry	yes, if applied professionally	yes, if blood smears are stored in 5% formaldehyde solution	microdens., cytom.
Electrophoresis	no, only prognosis possible	no	electrophor.
Measurement of erythrocytes	no, only prognosis possible	collection of air dried blood samples easily possible	erythr. size
Mating call analysis	probably yes, for distinguishing between diploid and polyploid (triploid, tetraploid) forms, but see <i>B. latastii</i>	yes	calls
External morphology, morphometry	no, only prognosis possible	yes	ext. morph.
Form and size of the clutch	no, often misleading	-	clutch

Evaluation of methods for the identification and determination of the ploidy in Asian green toads (Table 5)

Some forms/species of Middle and Central Asian green toads have been partly identified using misleading or ambiguous methods (comp. also Stöck and Grosse, 1997a).

The karyological analysis still remains an essential tool. The treatment with colchicine and the preparation of bone marrow, spleen or intestine tissue for the counting of stained chromosomes (e.g., Schmid, 1978; Macgregor and Varley, 1983) requires the killing of the animals. The obtaining of blood by heart puncture with micro-syringes (e.g., Schroer, 1996) and the determination of the ploidy by chromosome counts from blood cultures (Castellano and Giacoma, 1998) causes little mortality but requires the transport of the toads to the laboratory.

Flow cytometry is another unequivocal technique (Murphy et al., 1997 for review). The preferable storage of blood by freezing in liquid nitrogen is usually limited in the field. Ethanol fixation of blood obtained from anaesthized toads allows a storage for some weeks and the ploidy determination by flow cytometry if refrigeration is possible (e.g., Stöck et al., 1999), but does not allow the exact determination of absolute DNA-contents.

Feulgen staining of erythrocytes and the microdensitometrical determination of their DNA-

content provides also unequivocal results (Stöck and Grosse, 1997a). Although better results can be obtained if applied in the laboratory since the storage of air dried blood causes a loss of stainability, we recently got good results with blood smears which were stored in 5% formaldehyde solution until staining (our unpublished data). The obtaining of blood smears from the tip of the finger seems to be of very little damage for the animals, but requires to prevent the pollution of blood samples with skin mucus.

Significant differences in the average erythrocyte size allow a prognosis of the ploidy level (Stöck and Grosse 1997a). Discrimination problems occur because some populations exhibit values in the overlapping range between diploid and tetraploid toads. In addition, the classification of triploid individuals remains unsolved. In probably all-triploid populations from Karakoram, the mean erythrocyte areas exhibited significant differences to diploid and tetraploid populations (Stöck et al., 1999), but the variability of the individual erythrocyte size shows a large overlapping with diploid and tetraploid specimens. Unfortunately, these phenomena also prevent an exact analysis of the ploidy level of museum and type specimens with the technique of Mercadal (1981).

Results of protein electrophoresis (e.g., Borkin and Sokolova 1989, Mezhzherin and Pisanets, 1995a, 1995b) can usually not substitute the preceding ploidy determination since "electromorphs" may cause misinterpretations. Some authors of electrophoretic stud-

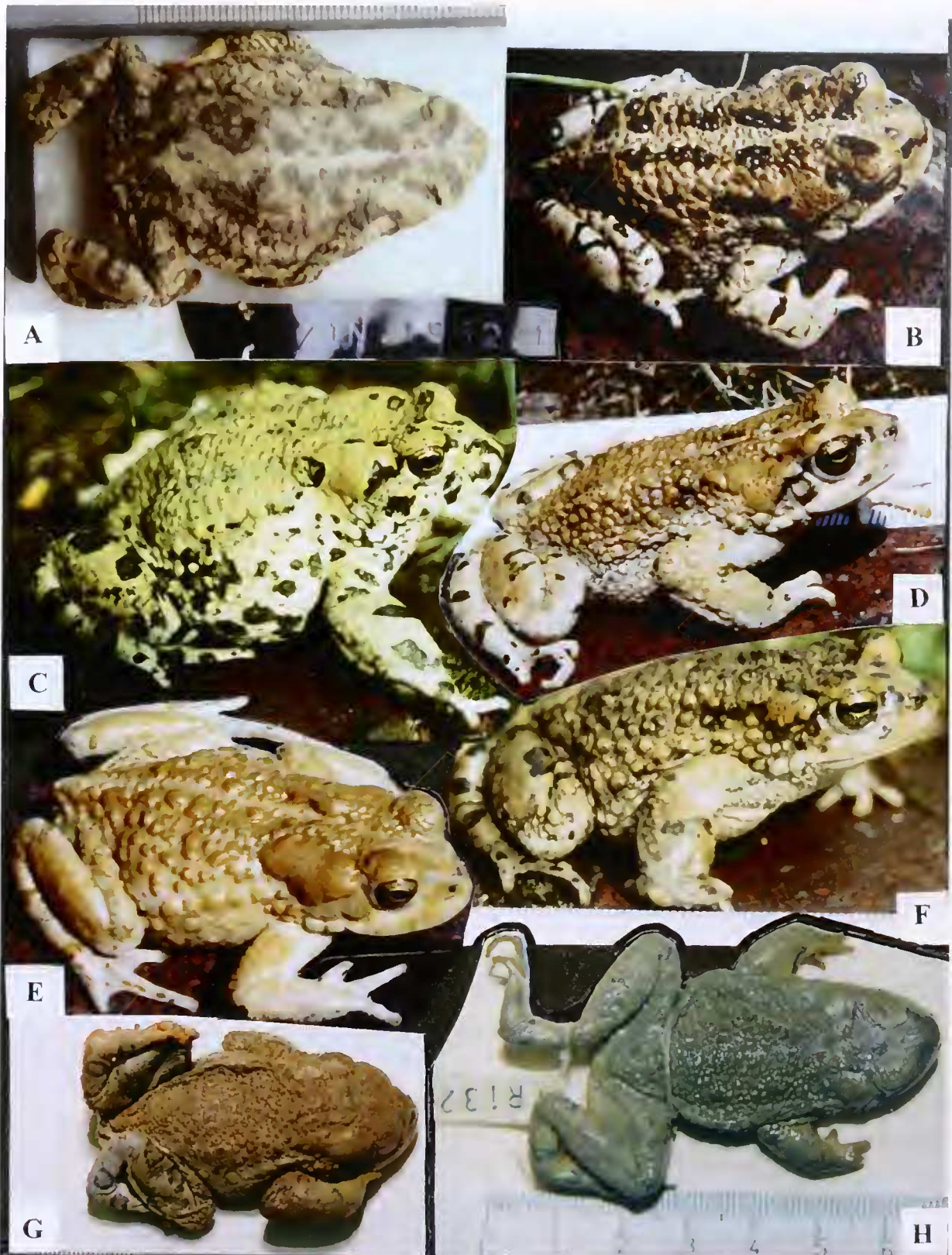


Figure 8. A - Lectotype (present designation) of *Bufo oblongus* Nikolsky, 1896 (Z ISP 1952.1) from Birjand, E-Iran. B - Topotypic tetraploid female *Bufo oblongus* from Birjand. C - Diploid male from Gholaman. D - Topotypic tetraploid male *Bufo oblongus* from Birjand. E - Topotypic diploid male of *Bufo viridis kermanensis* Eiselt & Schmidtler, 1971. F - Tetraploid male from Baghestan. G - Holotype of *Bufo kavirensis*, Andrén & Nilson, 1979. H - Holotype of *Bufo luristanicus* Schmidt, 1952.

ies did not describe whether or how they determined the ploidy level (e.g., Mezhzherin and Pisanets, 1991).

At any given temperature mating calls of tetraploid toads exhibited longer pulses and interpulse intervals resulting in lower pulse rates than diploid toads (Stöck 1997a, 1998a), a finding which exhibits parallels in other diploid/tetraploid anuran species (Hylidae, Leptodaetylidae) and artificial tetraploids suggesting that differences are caused by polyploidy (Gerhardt, 1994: 317).

For triploid toads from northern Kyrgyzstan (Castellano et al., 1998) and triploid populations from northern Pakistan (Stöck et al., 1998, 1999) call parameters were found to resemble those of tetraploid toads. Therefore, the mating call analysis seems suitable for distinguishing between diploid and polyploid (triploid, tetraploid) green toads. However, independently from polyploidisation, speciation in the *B. viridis* complex appears to take place also within each ploidy level and as in other anurans, evolutionary divergences in sympatry as well as convergences of call parameters in allopatry can be expected. The latter seems to be the case in diploid *B. latastii*, from which pulse rate data (Dubois and Martens, 1977) suggested a polyploid species (Stöck, 1998a).

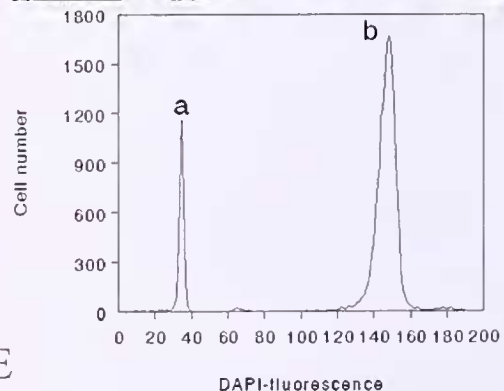
Many morphometric traits exhibited differences of the means but values showed large intersections between both diploid and tetraploid toads and morphometric parameters were not suitable for ploidy determination (Stöck, 1997b). The study announced by Roth (1986) on "about 2000 specimens from the whole range" has never been published (Roth, pers. comm.). In advance, Roth (1986) considered morphological characters "useless" for taxonomy but without determination of the ploidy level of the collection material. Multivariate analyses confirmed relationships between the ploidy level and the external character syndrome in diploid and tetraploid green toads (Stöck, 1997b; Castellano et al., 1998). Triploid toads from Kyrgyzstan exhibited more distinct differences to diploid than to tetraploid specimens (Castellano et al., 1998). Triploid populations in the Karakoram showed significant differences to both diploid and tet-

raploid toads from Central Asia in many characters with univariate methods (Stöck et al., 1999). A prognosis for the purely morphometric classification of diploid, triploid and tetraploid toads is possible with multivariate methods and this appears to be *one* tool for the prognostic assortment of preserved specimens in collections. The prognosis can be improved if morphometric data are combined with erythrocyte size data (Stöck, 1997b; Stöck and Grosse, 1997a; Stöck et al., 1999). In any case, the use of exact methods for ploidy determination is highly recommended (e.g., Borkin et al., 2000).

Pisanets (1987) indicated differences in form and size of the clutch between diploid and tetraploid toads



Figure 9. A, B - Lectotype of *Bufo latastii* Boulenger, 1882 (BMNH 1947.2.21.28, formerly 72.4.17.223), scale for B: 1 centimetre. C, D - Male *B. latastii* (ZMB 62721) examined from Skardu, Baltistan. E - Histogram obtained by DNA flow cytometry from a mixture of DAPI stained blood samples with chicken as the standard (a), CV = 2.94%, and diploid *B. latastii* from Skardu (b), CV = 2.74%. Total cell number 22 744.



from Turkmenistan (Kurukhaudan village, 12). The character is occasionally misleading (Kuzmin, 1995: 94; Stöck and Grosse, 1997a) although it was infrequently used for the identification of toads for further investigations (e.g., Mezherin and Pisanets, 1990).

Distribution

In general, the present map (Fig. 1) does not completely reflect the occurrence of green toads whose ploidy is known but also illustrates the recent degree of investigation.

Diploid toads (black arrows without starlet). The records of green toads found to be diploid in Middle Asia are distributed in the Turan Basin and are also concentrated at the foothills of the high mountains. Diploids have been found along the bottom part of the Kopet Dagh mountains (7, 8, 10, 11); a second group of records is to be seen in the Kafirnigan and Vakhsh river valleys (23, 25, 28, 29). The last records seem to exemplify a dispersion of diploid toads along the rivers into the mountain valleys. The western and particularly the northern Tien Shan form a third region with several records of diploid toads (31a, 36, 38, 39, 59, 59a). More distant from the mountains researches combined with ploidy determination have only sporadically been carried out. Merely some localities with doubtless diploid toads near the lower Amu-Darya (9, 14) and Zervashan river (17, 18) are known. The record of diploid toads from the Chingzhal river (61) in Kazakhstan by Golubev (1990) appears to be doubtful (Dujsebayaeva et al., 1997). The main range (maps in Dubois and Martens, 1977, Stöck et al., 1999) of the diploid *B. latastii* (N, 49) is the rather humid Kashmir valley and the surrounding rather arid mountain ranges.

The small and highly generalized map by Kuzmin (1995: 182) and the more detailed one (Kuzmin, 1999: 479) show either a continuous range or many separate symbols of (diploid) *B. viridis* in Middle Asia and Kazakhstan. Both maps cannot reflect the detailed records and/or were not based on karyological studies. Therefore, Kuzmin (1995, 1999) also announced that the distribution requires additional investigations. However, Kuzmin's maps refer to the occurrence of diploid green toads in the Turan Basin along the rivers whereas the symbols for (diploid) *B. viridis* in the Inner Tien Shan and around the Issyk-Kul appear to be very doubtful (e.g. see Borkin, 1989).

In spite of only few references which contained data on the ploidy level and on the altitudinal distribution, the occurrence of diploid toads in Middle Asia apparently exceeds 1600 m a.s.l. only in rare cases (appendix; Castellano et al., 1998: "At least in Kazakhstan and Kyrgyzstan no diploid populations have

been found above 2000 m a.s.l."). Many papers (summarized e.g. by Meinig, 1995) reporting the occurrence of "*B. viridis*" until 4000 m a.s.l. in Central Asia, very probably represent data on polyploid toads. This also may account for Kuzmin's (1999) material who reported on *B. viridis* up to 3200 m a.s.l. in Middle Asia.

Tetraploid toads (white arrows). The tetraploid toads are largely distributed in the Middle and Central Asian mountain systems. They have been described from the Kopet Dagh (5, 6, 8, 11, 12), the Gissar range including its southern spurs (21 to 27, 27a, 30), the western Tien Shan (31a, 32, 33, 40), the northern Tien Shan and the Issyk-Kul gorge (39, 51 to 59, 59b, 60), the Central Tien Shan (42, 51), the margins of the Taklamakan desert (43, 50?), the region between Zailiyskiy Alatau and lake Balkhash (60, 37, 37a, 37b), the Dzungarian Alatau (60a, 60b), the eastern Tien Shan (63), and Dzungaria (62, 64, 66 to 72). In the Pamirs, tetraploid toads have been found in the western (34, 35) and in the central parts (45). Furthermore, Stöck (1998b) found toads from eastern Pamirs (44) to be tetraploid. They were recently described by Fei et al. (1999) as a new subspecies (T). The present map provides arguments for a rather continuous distribution of tetraploid toads from Eastern Tien Shan to the Dzungarian Gobi in Mongolia. Interestingly, eastern of about 80° E only records of tetraploids and obviously no record of diploid toads have been made. Various records underline the high ecological plasticity especially of the tetraploid green toads (e.g. Dujsebayaeva et al., 1997). The dry centers of the large continental deserts Kyzylkum, Karakum, Muyunkum and Betpak-Dala seem to be not suitable as habitats of (tetraploid) green toads but this might be also caused by the recent low degree of investigation. Considering some records of tetraploids in the eastern plane regions, some additional records of tetraploid toads in the Turan lowlands can be expected in future. The tetraploids in the West of the known range (Kopet Dagh) may have a rather continuous distribution via the mountains of Afghanistan until those of the Pamiro-Alai-System, but data from Afghanistan are recently too scarce for a detailed analysis.

Triploid toads (black arrows with starlet). For the first time, probable triploidy of three specimens was detected by Bachmann et al. (1978: "36% more DNA than diploid *Bufo viridis*") in toads (presumably) originating from Kabul (48f in Fig.1; Hemmer et al., 1978: 352, 370). Triploid individuals have been detected in south-western Turkmenistan (5), in northern Kyrgyzstan (39) and south-eastern Kazakhstan; the last record was reported without particular locality

(Borkin et al., 1997, 2000) and we did not draw it in the map. The rare occurrence of triploid individuals in the Central Pamirs (45) has been concluded from isozyme data (Mezhzherin and Pisanets 1990). Most of the authors supposed a hybrid origin of triploids as a result of mismatings between diploid and tetraploid toads or only noted the occurrence in contact zones of diploid and tetraploid toads (Borkin et al., 1997, 2000). Preliminarily, Lattes (1997) and Cervella et al. (1997) indicated that triploids from Kyrgyzstan (Kokjar, near 39; Castellano et al., 1998) do not originate from hybridizations between diploid and tetraploids but seem to be closely related forms of the tetraploids. Presumably all-triploid populations of green toads from the Karakoram range and Western Himalayas (46, 47, 48a) have been discovered by Stöck et al. (1998) and were described as a new subspecies (Stöck et al., 1999). The new data from Pakistan (47a, 48b-e) suggest that triploids, which form at least at some localities (e.g., 47) all-triploid gonochoristic populations, are distributed along the upper tributaries of the Gilgit river (48b), they live at the Shandur pass (48c, 3720 m a.s.l), and also in the Central Hindukush, i.e. the Chitral valley (48d, e). Interestingly, in the Karakoram exists obviously an eastern limit of the distribution of triploids situated between their most eastern record (48a) and the most western one (49) of diploid *B. latastii* in the gorge of the Indus river. Based only on morphological characters, Baig (1998) reported on the sympatric occurrence of "*Bufo latastii*" and "*B. pseudoraddei*" in the "Neelam valley" (= Jhelum valley) of Azad Kashmir in eastern Pakistan.

Generally, the correlation of distributional data on green toads with global climatic factors appears to be problematic because the local or microclimatic conditions to which the animals are adapted may differ strongly from the climatic zone in which any locality is situated.

Zoogeographic implications. Borkin (1999: 350) considered "the *B. viridis* group as an indicator of southern limits of the Palearctic in arid regions". Mazik et al. (1976) as well as Pisanets (1978) already reported an allopatric occurrence of diploid and tetraploid green toads because they have different ecological preferences. This hypothesis is principally supported by the present map but it seems more appropriate to call the ranges parapatric (Borkin et al., 1997). Many authors (Pisanets and Shcherbak, 1979; Toktosunov, 1984; Borkin et al., 1986b, c; Borkin and Kuzmin, 1988) arranged the tetraploids of the arid foothill regions in contrast to those of the high mountains. In our opinion, it appears possible that the limiting climatic factors in the high mountains as well as in

the more continental high plains are similar and are obviously suitable only for polyploid green toads.

At the moment, the causes for the specific distribution pattern remain speculation. Kuzmin (1995: 189, 1999) refers to the high degree of temperature tolerance of tetraploid green toads (-30°C to 45°C). In the high mountain habitats as well as in the continental deserts strong daily and annual variations of temperatures as well as a high mean annual solar radiance (e.g. in the northern Asian deserts 2700-2800 h, in the interior Tien Shan > 2600 h, see Zlotin, 1997) might have caused a genetically caused selective advantage of the polyploid forms. This may also account for the missing of diploid toads in the east of the range where only tetraploids have been detected. The eastern boundary of the range of tetraploid green toads and the obviously parapatric occurrence of *B. raddei* in Northern China and Western Mongolia was discussed by Peters (1971: "*B. viridis*" for tetraploids), Borkin and Kuzmin (1988), and Stöck (1998b). The most western known records of tetraploids (Kopet Dagh, Khorasan) seem to correspond with the region of transition from winter-mild, summer-dry steppe climates of Middle Asia and Afghanistan to the winter-humid, summer-dry climates of Mediterranean type in Iran (Walter and Lieth, 1967; Müller, 1996). The deserts of Central Iran with fewer than 100 mm rainfall/year and large sand or salt areas seem to separate the polyploids in the East of Central Iran (and Afghanistan?) from the diploids in the West. Although *B. surdus* may provide unexpected karyological data, at the moment, in spite of only few studies, records of polyploid green toads in the West of Iran appear to some extent improbable. This may rather result from the history of distribution than from the possible relationship between polyploidy and environmental selective pressure.

The present image of the distribution of diploid and tetraploid toads possibly also corresponds to the experience that (especially allo-)polyploid organisms may have advantages in regions with extreme or changing environments (Futuyama 1990: 69 - "polyploids are more resistant"), when colonizing new habitats (Bretagnolle et al. 1998) or were considered to have a higher competitive ability (e.g., Lumaret et al., 1997). However, particularly the distribution of diploid plant species and their polyploid relatives probably more strongly reflects the influence of historical factors than of their current ecological requirements (Bretagnolle et al. 1998) or adaptedness. Morescalchi (1990) stated: "In amphibians, changes in genome size (...), far from being random, they are related to metabolic and ontogenetic factors which are of crucial importance in the adaptive strategies of these animals".

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Appendix 1.

Loc.-No.	Ploidy	Topographic description	Source	Method
1	2n	Iran, Zagros Mountains, Gholaman, 30 km W Khorram Abad, 33°25' N, 48°12' E	present paper	erythr. size, microdens.
1a	2n	Iran, SW-slope of Zagros mountains, Khuzestan Province, Choqa Zanbil, 32°31' N, 48°32' E, 560 m a.s.l.	present paper	flow cytom.
2	2n	Iran, N-slope of Elburz mountains, valley 15 km S Gorgan, approx. 1100 m a.s.l.	Stöck (1995)	chrom. count. of larvae and juveniles
2a	2n	Iran, S-slope of Elburz mountains, N of Theran, near Polur, approx. 2350 m a.s.l.	Martens unpublished, present paper	calls
2b	2n	Iran, S-slope of Elburz mountains, N of Theran, valley NE of Fasham, approx. 2540 m a.s.l.	Martens unpublished, present paper	calls
	2n	Iran, S-slope of Elburz mountains, Lar valley NE	Andrén and Nilson (1979), present paper	calls
2c	2n	Iran, Tehran Province, N environs of Tehran, garden of Plant Pests and Diseases Research Institute	Borkin et al. (2000)	flow cytom.
2d	2n	Iran, Tehran Province, approx. 70 km W of Karaj, Karpuz-Abad village	Borkin et al. (2000)	flow cytom.
3	2n	Iran, NE, frontier zone near Turkmenistan, approx. 50 km NE Gonbad-e-Kavus, 250 m a.s.l., 37°38' N, 55°29' E	Stöck (1997a), Stöck and Grosse (1997a), Stöck (1998a)	chrom. count. of larvae, adults, erythr. size
4	4n	Turkmenistan, Nebit-Dagkii Rayon, N-slope of Bolshoi Balkhan, approx. 15 km S of Oglanly village, 500 m a.s.l., 39°43' N, 54°29' E	Stöck (1997a), Stöck and Grosse (1997a), Stöck (1998a)	chrom. count. of larvae, adults, erythr. size, calls
5	2n	Turkmenistan, Ashgabadskaya oblast, near Danata	Pisanets (1978), Borkin et al. (1986a)	chrom. count.
	2n	- " -	Mezhzherin and Pisanets (1990), Pisanets (1992a)	ext. morph.
	4n, 3n	- " -	Pisanets (1978)	chrom. count.
	4n	- " -	Borkin et al. (1986a)	chrom. count.
	4n	- " -	Mezhzherin and Pisanets (1990), Mezhzherin and Pisanets (1991), Mezhzherin and Pisanets (1995a, b)	chrom. count. and/or ext. morph.
	4n	- " -	Ataev (1987), Pisanets (1992a)	ext. morph.
	4n	- " -	Pisanets (1992b)	chrom. count., ext. morph.
	4n	Turkmenistan, Ashgabadskaya oblast, stream 2-4 km SE of Danata village and warm spring approx. 4 km SE of Danata, 200 m a.s.l.	Stöck (1997a), Stöck and Grosse (1997a), Stöck (1998a)	chrom. count. of larvae, adults, erythr. size, calls
?	4n	"South-west Kopet-Dagh", not exactly localized	Pisanets and Vasilenko (1995)	method not described
6	4n	Turkmenistan, Kuruchsudon-Reserve, Kopet-Dag (not exactly localized)	Borkin et al. (1986a)	chrom. count. and/or flow cytom.
7	2n	Turkmenistan, Kyzyl-Arvatskii Rayon, Kopet-Dag-Range, valley approx. 25 km SW of the station Bami, S of the pass, 750 m a.s.l., 38°37' N, 56°38' E	Stöck (1997a), Stöck and Grosse (1997a), Stöck (1998a)	chrom. count. of larvae, erythr. size, microdens.
8	2n	Turkmenistan, Aydere-oasis, E Kara-Kala	Borkin et al. (1986a)	chrom. count. and/or flow cytom.
	4n	Turkmenistan, Adere-oasis, E Kara-Kala	Borkin et al. (1986a)	chrom. count. and/or flow cytom.
	4n	Turkmenistan, Kara-Kala	Mezhzherin and Pisanets (1995a, b)	chrom. count. and/or ext. morph.
9	2n	Turkmenistan, lake Sarykamys	Borkin et al. (1986a)	chrom. count.
9a	2n	Kazakhstan, Guryev Town, Chornaya Rechka	Schneider and Egiasaryan (1995), Dujsebayaeva et al. (1997)	calls
10	2n	Turkmenistan, Ashgabadskaya oblast, Bacharden	Pisanets (1992a)	ext. morph.
	2n	- " -	Mezhzherin and Pisanets (1991)	method not mentioned
	2n	Turkmenistan, Ashgabadskaya oblast, Bacharden	Mezhzherin and Pisanets (1995a, b)	chrom. count. and/or ext. morph.
	2n	Turkmenistan, Ashgabadskaya oblast, S Bacharden, approx. 10 km W Kelyata, 500 m a.s.l., 38°14' N, 57°31' E	Stöck (1997a), Stöck and Grosse (1997a), Stöck (1998a)	chrom. count. of larvae, erythr. size, microdens.
11	2n	Turkmenistan, Ashgabadskaya oblast, near Ashgabad	Borkin et al. (1986a)	chrom. count.
	2n	- " -	Mezhzherin and Pisanets (1990), Mezhzherin and Pisanets (1991)	ext. morph.
	2n	Turkmenistan, Ashgabad, village Kodzh	Mezhzherin and Pisanets (1991)	method not mentioned
	2n	- " -	Mezhzherin and Pisanets (1995a, b)	chrom. count. and/or ext. morph.
	2n	Turkmenistan, Ashgabadskaya oblast, near Ashgabad	Pisanets and Vasilenko (1995)	method not described
	2n	- " -	Pisanets (1991)	chrom. count.
	2n	Turkmenistan, Ashgabadskaya oblast, Ashgabad	Stöck (1995)	chrom. count. of larvae
	4n	Turkmenistan, Ashgabad	Roth and Ráb (1986)	chrom. count.
12	4n	Turkmenistan, village Kuruchaudan	Pisanets (1987)	clutch
12a	2n	Iran, 20 km WNW Kapkan, Khorasan, 37°22' N, 58°32' E, 1670 m a.s.l.	present paper	erythr. size, microdens.
13	4n	Iran, 10 km NE Baghestan, Khorasan, N of Kuh-e-Kalat, 34°09' N, 58°25' E, 1900 m a.s.l.	Stöck et al. (1998a), present paper	chrom. count., erythr. size, microdens. and flow cytom.
13a	4n	Iran, Khorasan, Birjand, 32°33' N, 59°10' N, about 1500 m a.s.l.	present paper	chrom. count., flow cytom.
13b	2n	Iran, Kerman Province, Kerman, 30°18' N, 57°05' E, 1860 m a.s.l.	present paper	chrom. count., flow cytom.
13c	2n	Iran, Kerman Province, Bahr-e-Aseman Mountains, Sarduiyeh village in Sarduiyeh District, 2500 m a.s.l.	Borkin et al. (2000)	flow cytom.
14	2n	Turkmenistan, lake Shach-Senem (not exactly localized, SE of 9)	Borkin et al. (1986a)	chrom. count. and/or flow cytom.
15	2n	Turkmenistan, Ashgabadskaya oblast, near Iolotan	Mezhzherin and Pisanets (1990), Mezhzherin and Pisanets (1991)	ext. morph.
16	4n	Badchyz-Reserve, Akar Chechme	Pisanets (1978)	chrom. count.
	4n	- " -	Borkin et al. (1986a)	chrom. count.
	4n	- " -	Mezhzherin and Pisanets (1995a, b)	chrom. count. and/or ext. morph.
17	2n	Uzbekistan, Buchara	Roth and Ráb (1986)	chrom. count.

18	2n	Uzbekistan, Samarkand	Borkin et al. (1986a)	chrom. count
19	4n	Uzbekistan, Dzhisakskaya oblast, Rayon Farish, Nuratau-Reserve, N-slope of Nuratau Range, 900 - 1600 m a.s.l., 40°35' N, 66°30' E	Stöck (1997a), Stöck and Grosse (1997a), Stöck (1998a)	chrom. count. of larvae, adults, erythr. size, calls
	4n	Uzbekistan, Dzhisakskaya oblast, Rayon Farish, S bank of Aidar-Kul near of Nuratau- Range, 300 m a.s.l.	Stöck (1997a), Stöck and Grosse (1997a), Stöck (1998a)	chrom. count. of larvae, erythr. size, microdens., calls
20	4n	Tadzhikistan, 60 km E of mouth of Janob into Zeravshan river, right bank of Zeravshan river, near Pastigay	Kryukov et al. (1985)	chrom. count.
21	4n	Tadzhikistan, Gissar- Range, Ziddi, 3000 m a.s.l.	Borkin et al. (1986a)	chrom. count.
22	4n	Tadzhikistan, Ramit-gorge, Chulgaram	Borkin et al. (1986a)	chrom. count.
	4n	Tadzhikistan, Ramit-gorge, Chulgaram	Mezhzherin and Pisanets (1995a, b)	chrom. count. and/or ext. morph.
	4n	- " -	Pisanets (1992b)	chrom. count., ext. morph.
	4n	Tadzhikistan, 15 km SW of the mouth of Sardan-Miena and Sorbo, gorge of Kafirnigan, near Javroz	Kryukov et al. (1985)	chrom. count.
23	2n and 4n	Tadzhikistan, Dushanbe	Roth and Ráb (1986)	chrom. count.
	4n	Tadzhikistan, N Dushanbe	Kryukov et al. (1985)	chrom. count.
24	4n	Uzbekistan, Gissar- Range, 20 km of mouth of Tupalang-Darya, 800 m a.s.l.	Borkin et al. (1986a)	chrom. count.
25	2n	Tadzhikistan, 90 km SW Dushanbe, Kafirnigan-valley	Borkin et al. (1986a)	chrom. count.
26	4n	Tadzhikistan, 90 km S Dushanbe, Kafirnigan-valley, near Ismbai	Pisanets (1992b)	chrom. count., ext. morph.
27	4n	Tadzhikistan, S Pamir, near Lyangar	Mezhzherin and Pisanets (1990)	ext. morph.
	4n	Tadzhikistan, S Pamir, near Lyangar	Mezhzherin and Pisanets (1991)	method not mentioned
	4n	- " - 1800 m a.s.l.	Pisanets (1992b)	chrom. count., ext. morph.
27a	4n	Tadzhikistan, near Faizabad	Mezhzherin and Pisanets (1991)	method not mentioned
	4n	Tadzhikistan, near Faizabad	Pisanets (1991)	chrom. count.
	4n	Tadzhikistan, near Faizabad	Mezhzherin and Pisanets (1995a, b)	chrom. count. and/or ext. morph.
	4n	- " - ,localization using the information...120 km N of Dushanbe" in:	Pisanets (1992a)	ext. morph.
	4n	- " -	Pisanets (1992b)	chrom. count., ext. morph.
	4n	Tadzhikistan, Vakh valley, environs of Obi-Garm	Mezhzherin and Pisanets (1991)	method not mentioned
	4n	Tadzhikistan, Obi-Garm, 2300 m a.s.l.	Pisanets (1992a)	ext. morph.
	4n	Tadzhikistan, Obi-Garm	Mezhzherin and Pisanets (1995a, b)	chrom. count. and/or ext. morph.
	4n	- " -	Pisanets (1992b)	chrom. count., ext. morph.
27b	4n	Tadzhikistan, mouth of Komarou-river, 2000 m a.s.l (not exactly localized)	Borkin et al. (1986a)	chrom. count.
28	2n	Tadzhikistan, 10-12 km SW of the mouth of Vakhsh and Javansu, near Kurgan-Tjube	Kryukov et al. (1985)	chrom. count.
	2n	Tadzhikistan, 10-12 km W of the mouth of Vakhsh and Javansu, left of Vachsh, Kuibyshevskii Rayon	Kryukov et al. (1985)	chrom. count.
	2n	Tadzhikistan, 50 km NE of mouth of Vakhsh into Pyandzh, near Dusti	Kryukov et al. (1985)	chrom. count.
29	2n	Tadzhikistan, Chirik	Borkin et al. (1986a)	chrom. count.
	2n	environs of Chaartuz, Chirik	Pisanets (1991)	chrom. count.
	2n	Tadzhikistan, Beshkentskie peski, valley of Kafirnigan river, environs of Chaartuz	Mezhzherin and Pisanets (1991)	method not mentioned
	2n	- " -	Pisanets (1992a)	ext. morph.
30	4n	Tadzhikistan, S of Aktau-Range, 80 km S Dushanbe	Kryukov et al. (1985)	chrom. count.
31	4n	Uzbekistan, Tashkent	Borkin et al. (1986a)	chrom. count. and/or flow cytom.
	4n	- " -	Kudryavcev et al. (1988)	cytophotometry
	4n	- " -	Roth and Ráb (1986)	chrom. count.
	4n	Uzbekistan, Tashkent, 450 m a.s.l., 41°16' N, 69°13' E	Stöck (1997a), Stöck and Grosse (1997a), Stöck (1998a)	chrom. count. of larvae, adults, erythr. size, calls
31a	2n	Kazakhstan, environs of Chimkent	Mezhzherin and Pisanets (1995a, b)	chrom. count. and/or ext. morph.
	4n	Kazakhstan, environs of Chimkent	Mezhzherin and Pisanets (1991)	method not mentioned
31b	4n	Kazakhstan, Kyzyl-kum desert, 50 km SW of Bairkum village, Chimkent region, 250 m a.s.l., 67°25' N, 42°02' E	Dujsebayaeva et al. (1997), Castellano et al. (1998)	chrom. count.
31c	4n	Kazakhstan, Chimkent region, Jagbagly village, 1100 m a.s.l., 70°32' N, 42°25' E	Dujsebayaeva et al. (1997), Castellano et al. (1998)	chrom. count.
32	4n	Uzbekistan, 80 km E Tashkent, entry of Chatkal-Reserve, 5 km SE Burchmulla, 900 m a.s.l., 41°35' N, 70°07' E	Stöck (1997a), Stöck and Grosse (1997a), Stöck (1998a)	chrom. count. and/or erythr. size, calls
33	4n	Uzbekistan, Kuraminsky-Range, 3000 m a.s.l.	Borkin et al. (1986a)	chrom. count.
34	4n	Tadzhikistan, S Pamir, near Khorog	Mezhzherin and Pisanets (1990)	ext. morph.
	4n	Tadzhikistan, Gorno-Badakhshan, S Pamir, near Khorog	Mezhzherin and Pisanets (1991)	method not mentioned
	4n	- " -	Mezhzherin and Pisanets (1995a, b)	chrom. count. and/or ext. morph.
	4n	- " -	Pisanets (1992a)	ext. morph.
35	4n	Tadzhikistan, S Pamir, near Ishkashim	Mezhzherin and Pisanets (1990)	ext. morph.
	4n	Tadzhikistan, Gorno-Badakhshan, S Pamir, near Ishkashim	Mezhzherin and Pisanets (1991)	method not mentioned
	4n	- " - 1800 m a.s.l.	Pisanets (1992b)	chrom. count., ext. morph.
	4n	Tadzhikistan, S Pamir, near Ishkashim	Mezhzherin and Pisanets (1995a, b)	chrom. count. and/or ext. morph.
36	2n	Kazakhstan, Dzhambul	Roth and Ráb (1986)	chrom. count.
36a	2n	(outside the map) Kazakhstan, Tengis Lake, 12 km W of Abaya village, about 50°40' N, 69°40' E	Dieterich leg., examined by Stöck, unpublished	flow cytometry (one specimen)
37	4n	Kazakhstan, desert near Burubaital, S Balchash lake region	Egembergdieva (1983) cited by Borkin et al. (1986a)	unknown, original paper not available
	4n	Kazakhstan, desert near Burubaital, S Balchash lake region	Borkin et al. (1995)	flow cytometry

37a	4n	Kazakhstan, Karaoi village, 350 m a.s.l., 74°47' N, 45°54' E	Dujsebayaeva et al. (1997), Castellano et al. (1998)	chrom. count., calls
37b	4n	Kazakhstan, Zhidely Channel, Ili River Delta, 370 m a.s.l., 75°12' N, 45°18' E	Dujsebayaeva et al. (1997), Castellano et al. (1998)	chrom. count., calls
38	2n	Kyrgyzstan, Chu-valley, 650 m a.s.l.	Mazik, Kadyrova and Toktosunov (1976) and cited by Borkin et al. (1986a)	chrom. count.
	2n	Kyrgyzstan, Chu-valley	Toktosunov and Mazik (1977)	method not mentioned
	2n	Kyrgyzstan, Tulek	Castellano et al. (1998)	chrom. count., calls
	2o	Kyrgyzstan, Tyulyok, not exactly localized	Borkin et al. (1986a)	chrom. count. and/or flow cytom.
39	2n	Kyrgyzstan, Frunze (Bishkek)	Bachmann et al. (1978)	cytophotometry
	2n	- "	Borkin et al. (1986a)	chrom. count. and/or flow cytom.
	3n	Kyrgyzstan, S Bishkek	Kuzmin (1995: 187)	method not described
	4n	Kyrgyzstan, Frunze (Bishkek)	Borkin et al. (1986a)	chrom. count.
	4n	Kyrgyzstan, environs of Frunze (Bishkek)	Mezhzherin and Pisanets (1991)	method not mentioned
	4n	- "	Bachmann et al. (1978)	cytophotometry
	2n	Kyrgyzstan, Bishkek (Frunze)	Stöck (1997a), Stöck and Grosse (1997a)	chrom. count. and/or erythr. size
?	4n	Kyrgyzstan, Kyrgyzskii Khrebet, 1200 m a.s.l. and 2500 m a.s.l., not exactly localized	Fikhtman (1989)	method not mentioned
?	2n, 3n, 4n	Kyrgyzstan, Kok-jar, 25 km S of Bishkek, approx. 1300 m a.s.l., artificial basin about 6 km from the village	Castellano et al. (1998)	chrom. count., calls
40	4n	Kyrgyzstan, Toktogul-valley, 900 m a.s.l.	Toktosunov (1984) and cited by Borkin et al. (1986a)	chrom. count.
41	2n?	Kyrgyzstan, SW slope of Fergana-Range, near Arslanbob, 1800 m a.s.l.	Pisanets and Shcherbak (1979)	method not described
	3n	- "	Stöck (unpublished)	chrom. count. (one juvenile animal)
	4n	- "	Borkin et al. (2000)	method not mentioned
42	4n	Kyrgyzstan, Arpa-valley, 3500 m a.s.l.	Toktosunov (1984) and cited by Borkin et al. (1986a)	chrom. count.
43	4n	China, Kashgar, 39°29'N, 76°02'E, 1350 m a.s.l.	Stöck (1998b)	chrom. count., flow cytom., and/or erythr. size, calls
44	4n	China, E-Pamir, Taxkurgan, 37°47'N, 75°14'E, 3350 m a.s.l.	Stöck et al. (1998a), Stöck (1998b)	chrom. count., calls
45	4n	Tadzhikistan, Central Pamir, lake Jashikul, 3734 m a.s.l.	Toimastov (1989)	ext. morph.
	4n	- " - (also 3n, 2n ?)	Mezhzherin and Pisanets (1990)	ext. morph.
	4n	- "	Mezhzherin and Pisanets (1991)	method not mentioned
	4n	- " - (also 3n, 2n ?)	Pisanets (1992a)	ext. morph.
	4n	- " - (also 3n, 2n ?)	Pisanets (1992b)	chrom. count., ext. morph.
	4n	- " - (also 3n, 2n ?)	Mezhzherin and Pisanets (1995a, b)	chrom. count. and/or ext. morph.
46	3n	Pakistan, Karakoram, Sust, Hunza-Valley, 36°46'N, 74°50'E, 2950 m a.s.l.	Stöck et al. (1998, 1999)	chrom. count., flow cytom., and/or erythr. size, calls
47	3n	Pakistan, Karakoram, Pasu, Hunza-Valley, 36°30'N, 74°52'E, 2600-2800 m a.s.l.	Stöck et al. (1998, 1999), present paper	chrom. count., flow cytom., and/or erythr. size, calls
47a	3n	Pakistan, Northern Areas, Hunza-Valley, river bank, Karimabad near Ganesh, 36°18'N, 74°41'E, 2060 m a.s.l.	present paper	flow cytom.
48	3n	Pakistan, W-Himalayas, Upper Swat valley, Kulalai, 35°19'N, 72°36'E, 1750 m a.s.l.	Stöck et al. (1998, 1999)	chrom. count. only one specimen), and/or erythr. size, calls
48a	3n	Pakistan, Northern Areas, Gilgit, 35°54'N, 74°24'E, 1550 m a.s.l.	Stöck et al. (1998, 1999)	chrom. count., flow cytom., and/or erythr. size, calls
48b	3n	Pakistan, Northern Areas, Gupis, 36°14'N, 73°27'E, opposite Yasin valley, 2160 m a.s.l.	present paper	flow cytom.
48c	3n	Pakistan, Shandur Pass, Lake, border of NW Frontier Prov. and Northern Areas, 3720 m a.s.l.	present paper	flow cytom.
48d	3n	Pakistan, NW Frontier Prov., Hindu-Kush, Buni, approx. 36°20'N, 72°20'E, approx. 1900 m a.s.l.	present paper	flow cytom.
48e	3n	Pakistan, NW Frontier Prov., Hindu-Kush, Chitral City, 35°53'N, 71°47'E, 1480 m a.s.l.	present paper	flow cytom.
48f	3n?	Afghanistan, Kabul ?, 34°31'N, 69°12'E, sample not surely localized for Kabul	Bachmann et al. (1978): "36% more DNA than diploid <i>B. viridis</i> ", Hemmer et al. (1978)	microdens.
49	2n	Pakistan, Northern Areas (Balistan), Himalaya, Satpara river SW of Skardu, 35°17'N, 75°37'E, 2300 m a.s.l., see also M and N	present paper	flow cytom., chrom. count
50 (?)	4n	China, Xinjiang, Hotan; localization in the present map not sure	Whu Min and Zhao Yajiang (1987)	chrom. count.
51	4n	Kyrgyzstan, Naryn	Stöck (unpublished)	chrom. count.
52	4n	Kyrgyzstan, Kara-Kudzhur-valley	Toktosunov (1984) and cited by Borkin et al. (1986a)	chrom. count.
52-57	4n	Kyrgyzstan, whole environs of Issyk-Kul, 1670 m a.s.l.	Mazik et al. (1976)	chrom. count.
	4n	- "	Toktosunov (1984) and cited by Borkin et al. (1986a)	chrom. count.
	4n	- "	Roth and Rüb (1987b)	chrom. count.
	4n	- "	Borkin (1989)	partly chrom. count.
	4n	- "	Mezhzherin and Pisanets (1995a, b)	chrom. count. and/or ext. morph.
	4n	- "	Fikhtman (1989)	method not mentioned
53	4n	Kyrgyzstan, Chu-valley, approx. 20 km W Rybache, near Kokmoynok, approx. 1600 m a.s.l.	Stöck (1997a), Stöck and Grosse (1997a)	erythr. size
	4n	Kyrgyzstan, SW bank of Issyk-Kul	Mezhzherin and Pisanets (1991)	method not mentioned

54	4n	Kyrgyzstan, Issyk-kul, N-bank near Sary-Kamysht, 1670 m a.s.l., 42°29' N, 76°20' E	Stöck (1997a), Stöck and Grosse (1997a), Stöck (1998a)	erythr size, calls
	4n	Kyrgyzstan, Issyk-kul	Castellano et al. (1998)	chrom. count., calls
55	4n	Kyrgyzstan, Issyk-kul, S-bank near Tamga, 1670 m a.s.l.	Stöck (1997a), Stöck and Grosse (1997a), Stöck (1998a)	chrom. count. of adults, erythr. size, calls
56	4n	Kyrgyzstan, Rayon Tyub, village Frunze	Borkin (1989)	partly chrom. count.
57	4n	Kyrgyzstan, NO-bank of Issyk-Kul, Rayon Tyub, near Kuturga	Borkin (1989)	partly chrom. count.
	4n	Kyrgyzstan, Issyk-kul, N-bank near Chon-Oryuktu, 1670 m a.s.l.	Stöck (1997a), Stöck and Grosse (1997a)	chrom. count. of adults, erythr. size
58	4n	Kyrgyzstan, Kemin-valley, 2500 m a.s.l.	Toktosunov (1984) and cited by Borkin et al. (1986a)	chrom. count.
59	2n	Kazakhstan, Almaty	Birstein (1981), Pisanets (1991)	chrom. count.
	2n	Kazakhstan, Almaty	Mezhzherin and Pisanets (1991)	method not mentioned
	4n	Kazakhstan, Almaty	Mezhzherin and Pisanets (1995a, b)	chrom. count. and/or ext. morph.
	4n	Kazakhstan, Almaty	Borkin et al. (1995)	flow cytometry
	4n	Kazakhstan, Almaty, 900 m a.s.l., 76°55' N, 43°15' E	Dujsebajeva et al. (1997), Castellano et al. (1998)	chrom. count., calls
59a	2n	Kazakhstan, Kopa, 20 km S of Kopa station, 75°47' N, 43°25' E	Dujsebajeva et al. (1997), Castellano et al. (1998)	chrom. count., calls
59b	4n	Big Almaty Lake, Zailiskii Alatau Range, 2300 m a.s.l., 77°N, 43°04' E	Dujsebajeva et al. (1997), Castellano et al. (1998)	chrom. count., calls
60	4n	Kazakhstan, Kapchagay, Ili-river	Borkin et al. (1986a), Borkin et al. (1995)	chrom. count. and/or flow cytometry
60a	4n	Kazakhstan, Bashui, 1 km S Altyn-Emel Mountain Range 44°10' N, 78°45' E	Borkin et al. (1995)	flow cytometry
60b	4n	S foothills of the Koyandytau Mountain Range	Borkin et al. (1995)	flow cytometry
	4n	Ayan-Saz Point, Borokhudzir river valley, between Koyandytau and Dsungarian Alatau Mountains	Borkin et al. (1995)	flow cytometry
61	2n?, 4n	Kazakhstan, valley of river Chungzhal, basin of lake Alakol, 6-10 km near Andreevka	Golubev (1990)	method not mentioned
	4n	Kazakhstan, Andreevka	Mezhzherin and Pisanets (1995a, b)	chrom. count. and/or ext. morph.
	4n	Kazakhstan, Taldy-Kurganskaya oblast	Pisanets (1992b)	chrom. count., ext. morph.
	4n	Kazakhstan, Ucharal	Mezhzherin and Pisanets (1995a, b)	chrom. count. and/or ext. morph.
62	4n	China, Xinjiang, Wusu (Usu ?)	Wu Min and Zhao Yajiang (1987)	chrom. count.
63	4n	China, E-Tian Shan (E-Narat Shan), Kunas 43°14' N, 84°40' E, 2145 m	Stöck (1998b)	chrom. count., calls
65	4n	Kazakhstan, Akstir-Farm, Zaysan-lake	Borkin et al. (1986a)	chrom. count.
	4n	SW-part of Zaysan-gorge, 12 km NW of settlement Maikapchagay near Akstir-Farm	Shcherhak and Golubev (1981)	method not mentioned
64	4n	China, Xinjiang, Wulumuqi (Ürümqi)	Wu Min and Zhao Yajiang (1987)	chrom. count.
66	4n	Mongolia, river Ded-Nariin-Gol, S-slope of Mongolian Altai, 2000 m a.s.l., 12 of the detailed map in:	Borkin and Kuzmin (1988)	mostly chrom. count.
67	4n	Mongolia, oasis Chug-Bulag, Bulgan-Somon, Chovd-Aimak	Borkin et al. (1986b)	chrom. count.
	4n	corresponds to 1, 2 and 3 of the detailed map in:	Borkin and Kuzmin (1988)	chrom. count.
68	4n	Mongolia, 60 km W of settlement Bulgan, Chovd Aimak, river Bulgan-Gol	Meyer (1991)	ext. morph.
69	4n	Mongolia, spring Chujten-Bulak, S-slope of Mongolian Altai, 2000 m a.s.l., spring Bayan-Mod, 15 km N of spring Icher-Tol, 1600 m spring Icher-Tol, 83 km NW of settlement Bulgan, 1600 m a.s.l., spring Chavchig-Us or Chavchig-Bulag-spring Shara-Bulag	Borkin and Kuzmin (1988)	partly chrom. count.
70	4n	Mongolia, river Uench-Gol, 46°n.B., 92°w. L., 1350 m a.s.l. (11 of the detailed map in:	Borkin and Kuzmin (1988)	partly chrom. count.
	4n	Mongolia, spring Jaman-Usny-Bulag or Jaman-Us, 30 km E of settlement Uench, 1800 m a.s.l., 12 of the detailed map in:	Borkin and Kuzmin (1988)	partly chrom. count.
71	4n	Mongolia, oasis Ushigiin-Us, Dsungarian Gobi, 90 km SW of settlement Bulgan, 9 of the detailed map in:	Borkin and Kuzmin (1988), Orlova and Uteshev (1986)	partly chrom. count.
72	4n'	Mongolia, spring Dondzhigiin-Us, Dsungarian Gobi, 85 km S of settlement Bulgan, 10 of the detailed map in:	Borkin and Kuzmin (1988), Orlova and Uteshev (1986)	partly chrom. count.
73	4n	China, Xinjiang, Hami prefecture, 12 km NE Koumenzi, 2090 m a.s.l.	Zhao and Adler (1993)	ext. morph.
74	4n	China, Xinjiang, Hami	Wu Min and Zhao Yajiang (1987)	chrom. count.
A	?	Iran, Luristan, Shah Bazan, km 324 of the Transiranian railway, type locality of <i>Bufo (surdus) luristanicus</i>	Schmidt (1952, 1955), Schmidler and Schmidler (1969), Mertens (1971b), Eiselt and Schmidler (1973), see also Q, R, S	no ploidy determination
B	2n?	Iran, NW part of Central Iraman Plateau, Cheshmeh-ye Sefied-Ab, type locality of <i>Bufo kavirensis</i>	Andrén and Nilson (1979), Stöck (1998a):	diploid?, present paper
C	2n	Iran, Kerman, type locality of <i>Bufo viridis kermanensis</i>	Eiselt and Schmidler (1971), Hemmer et al. (1978), present paper	chrom. count., flow cytometry
D	4n	Turkmenistan, Achgabadsakaya oblast, Danata village, type locality of <i>Bufo danatensis</i>	Pisanets (1978), Borkin and Kuzmin (1988), see also number 5	chrom. count.
E	4n	E-Iran, Ssaman Shakhi mountains near Birjand, type locality of <i>Bufo oblongus</i>	Nikoľsky (1896, 1897), Eiselt and Schmidler (1973), Roth (1986), Borkin and Kuzmin (1988), present paper	chrom. count., flow cytometry
F	2n	Tadzhikistan, Dushanbe, type locality of <i>Bufo viridis turanensis</i>	Hemmer et al. (1978), Pisanets and Shcherbak (1979), Roth (1986), Borkin et al. (1986b), Kuzmin (1995, 1999), Mezhzherin and Pisanets (1995a, b), see also number 23	no ploidy determination of the type series

G	2n	Tadzhikistan, SW-part, Beshkent desert, near Shaartus, type locality of <i>Bufo shaartusiensis</i>	Pisanets (1991), Pisanets et al. (1996), Kuzmin (1999), see also number 29	chrom. count.
H	?	Pakistan, Pishin, type locality of <i>Bufo (viridis) zugmayeri</i>	Eiselt and Schmidler (1973), Borkin and Kuzmin (1988), Stöck et al. (1999), Borkin et al. (2000)	no ploidy determination
J	3n and/or 4n (?)	Kyrgyzstan, Arslanbob, type locality of <i>Bufo viridis asiomontanus</i>	Pisanets and Shcherbak (1979: diploid without determination), Borkin and Kuzmin (1988), Borkin et al. (1997), Kuzmin (1999), Borkin et al. (2000)	chrom. count. (only one triploid specimen tested by Stöck, unpubl.), calls
K	4n	Kyrgyzstan, Kokmoinok, terra typica of <i>Bufo (viridis) unicolor</i>	Kashchenko (1909), Stöck (1997a), Stöck and Grosse (1997a), Kuzmin (1999), see also number 52 to 57	chrom. count.
L	4n	China, Kashgar, one of three type localities of <i>Bufo nouettei</i> sensu Mocquard; type locality of the <i>B. nouettei</i> lectotype	Mocquard (1910), Borkin and Kuzmin (1988), Stöck (1998b), additional papers are cited in the last one	chrom. count., calls, flow cytometry
M	2n	Pakistan, Shino village near Siachen glacier, type locality of <i>Bufo siachinensis</i>	Khan (1997), Baig (1998), Stöck et al. (1998, 1999); junior synonym of <i>B. latastii</i> , see N and 49	chrom. count., flow cytometry
N	2n	N-India, Ladakh, a locality was not exactly described, terra typica of <i>Bufo latastii</i>	Boulenger (1882: 295), Dubois and Martens (1977), Hemmer et al. (1978), Pisanets and Shcherbak (1979), Gruber (1981), Borkin et al. (1986a), Roth (1986), Borkin and Kuzmin (1988), Khan (1997), Baig (1998), Kuzmin (1999), Stöck et al. (1999), see M and 49	chrom. count., flow cytometry
O	3n	Pakistan, Swat valley, Mingora province, terra typica of <i>Bufo (viridis) pseudoraddei pseudoraddei</i>	Mertens (1971a), Pisanets and Shcherbak (1979), Roth (1986), Borkin and Kuzmin (1988), Baig (1998), Kuzmin (1999), Stöck et al. (1999), additional papers are cited in the last one	chrom. count. (only one specimen), calls
P	3n	N-Pakistan, Karakoram, type locality of <i>Bufo pseudoraddei baturae</i>	Stöck et al. (1999)	chrom. count., calls, flow cytometry
Q	?	SE-Iran, Bazman, Tamin in Sarhad, Duz-Ab, Ziaret in Sarhad, type locality of <i>Bufo persicus</i>	Nikolsky (1899), Carvsky ("1925", 1926): "synonym of <i>B. surdus</i> ", Schmidt (1955), Schmidler and Schmidler (1969), Eiselt and Schmidler (1973), see also R and S	no ploidy determination
R	?	Belutchistan (W-Pakistan?), not exactly localized, terra typica of <i>Bufo surdus</i>	Boulenger (1891), Carevsky ("1925", 1926), Schmidler and Schmidler (1969), Eiselt and Schmidler (1973), see also Q and S	no ploidy determination
S	?	SW-Iran, Mehkuh, 70 km S of Shiraz, type locality of <i>Bufo surdus annulatus</i>	Schmidler and Schmidler (1969), Eiselt and Schmidler (1973)	no ploidy determination
T	4n	China, type locality of <i>Bufo</i> ssp. <i>taxkorensis</i>	Fei et al. (1999), Stöck (1998b)	no ploidy determination in ssp. description, Stöck (1998b): chrom. count. (only one specimen), calls
U	?	China, Kok-Far (= Kokyar), type locality of the depicted specimen of <i>Bufo viridis</i> var. <i>pewzowi</i> ; three other type localities for the series	Bedriaga (1898: 61 and Fig. 2, plate 1), Hemmer et al. (1978), Borkin and Kuzmin (1988), Fei et al. (1999)	no ploidy determination
V	?	China, Tschik-Tym (= Qiktüm), Turfan, type locality of <i>Bufo viridis</i> var. <i>gran-grzimailoi</i> ; "Turfan": one of 14 type localities of <i>Bufo viridis</i> var. <i>strauchi</i>	Bedriaga (1898: 61), Hemmer et al. (1978), Borkin and Kuzmin (1988)	no ploidy determination